COLONIAL AND CAMP SANITATION

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BY

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WITH 11 ILLUSTRATIONS

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PREFACE

It has been represented to the author that the publication of a few extracts from his larger works might meet the wants of persons living in remote places in the Colonies or elsewhere, by furnishing them with correct principles of sanitation. The following pages have accordingly been taken from 'The Milroy Lectures' and 'The Dwelling-house,' as containing matter which is applicable to camp and colonial sanitation.

24A Portland Place,
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CONTENTS

CHAPTER I

CHAPTER II

ILLUSTRATIONS

CHAPTER I

THE SANITATION OF CAMPS—FLIES AND THE SCIENCE OF SCAVENGING[1]

IN the recent debate[2] at the Clinical Society of London on Dr. H. H. Tooth's paper[3] on enteric fever in South Africa it was established: (1) that the number of flies in our camps was prodigious; and (2) that these flies were largely a result of the military occupation. There seems also to have been a very general consensus of opinion (3) that flies may convey infection. It becomes therefore of great importance to consider the genesis of flies; and I trust that one who has no claims to be considered a dipterologist may be pardoned for recalling a few common facts.

Flies multiply at a prodigious rate. Given a temperature sufficiently high to hatch the eggs, their numbers are only limited by the amount of food available for them. Linnæus is credited with the saying that three meat-flies, by reason of their rapid multiplication, would consume a dead horse quicker than would a lion, and the fact that certain diptera having some outward resemblance to the honey-bee lay their eggs in the dead carcasses of animals probably led Samson and Virgil to

[1] Reprinted from the *Lancet*, May 18, 1901.
[2] *Ibid.* March 16, p. 786, and 30, 1901, p. 932.
[3] *Ibid.* March 16, 1901, p. 769.

make erroneous statements with regard to the genesis of honey and the manufacture of bees. The breeding of 'gentles' for ground-bait is an industry the practisers of which could probably give much information as to the nicety of choice exercised by flies in selecting material for feeding and egg-laying. According to Packard the house-fly makes selection of horse-dung by preference for ovipositing, and as each female lays about 120 eggs and the cycle of changes from egg to fly is completed in less than three weeks it seems probable that a female fly might have some 25,000,000 descendants in the course of a hot summer. Other varieties of flies multiply, I believe, still more rapidly.

As flies multiply upon, and in, organic refuse of every kind it is obvious that the sooner such refuse is placed where it cannot serve for the feeding and hatching of flies the more likely is the plague of flies to be lessened. The most commonly available method for the bestowal of organic refuse is burial. The egg-laying of flies in dead carcasses commences at the very instant of death, or even before death in the case of enfeebled animals. This fact has been insisted upon by Mégnin in 'La Faune des Cadavres,' and appears to be true of human beings dying from fever. It is obvious, therefore, that there must be no delay in the burial of organic refuse, and that the burial of animals and excreta is quite as important as the burial of human beings. After a great battle it may not be possible to follow this advice, but nevertheless there can be no harm in insisting that the instant burial of all organic refuse must be the aim of those who are called upon to guard the public health, whether military or civil.

It is impossible to lay down any line of action which shall be the best in all circumstances, and those

who, like myself, have not been through the South African campaign are incompetent to deal with the special circumstances of that campaign. Nevertheless, I am of opinion that much that I have witnessed on Salisbury Plain in connection with camp-scavenging is bad and is not calculated to teach the soldier the right principles of dealing with organic refuse, which is always his most dangerous enemy. The science of scavenging requires to be taught. If the duty of scavenging be left to the ignorant and be controlled by persons who think that necessary details are beneath their notice, then annoyance and disease are the only results possible.

If the scavengings of a camp are to be satisfactorily dealt with the question of their ultimate disposal must be ever present in the mind of the scavenger. The materials collected have to be burnt, to be buried, or to be otherwise dealt with. The mere dumping of refuse in mixed heaps ought certainly to be abandoned, and the contents of the latrines ought to undergo immediate superficial burial at the nearest available spot in order to avoid cartage and spilling. In many cases it should be possible to bury the excreta in the immediate vicinity of the spot where they are dropped. We hear of excreta being buried in trenches ten feet deep, but such a course must mean that they are left exposed to give off odours and to breed flies for many hours before they are under ground and covered up. I have consulted a gravedigger on this question and asked him, 'If you were ordered to dig a grave ten feet deep what breadth and length would be necessary, and what time would you require?' His reply was that (in chalk) the grave would have to be six and a half feet long and three and a half feet wide, and that he would require a day and a half to

complete the work. It is certain that thirty-six or forty-eight hours' delay in the disposal of fæces is most undesirable. I have always advocated the burial of fæces in shallow furrows rather than in deep trenches, and, in this country at least, where alone I have had experience, I am convinced that this is the only reasonable course to pursue. If properly done all offence to eyes or nose is thus ended and the fæces cease to attract either flies or rats. The fæces can be covered continuously as soon as they are dropped, and there is no need of having malodorous open trenches partially filled which are waiting to be completely filled before being covered up.

This burial of fæces must be done methodically and carefully and with every attention to detail. The proceedings must be precisely those of a gardener who is intent upon raising crops. The fact that in war the crops may never be harvested is quite beside the mark and affords no excuse for slovenly procedures which are a danger to health. Nitrification in the soil is the aim equally of the sanitarian and the agriculturist. If a plot of ground fifty yards long and fifty yards wide—slightly more than half an acre—be allotted for the disposal of fæces this should be marked off into, say, sixteen strips, each about eight feet wide and fifty yards long, with a narrow path of about eighteen inches between each strip to allow for watering and cultivation. The line of the furrows must be accurately marked by a cord and reel in the ordinary way, and the digger must move continuously backwards in order to avoid trampling on the freshly dug ground. The making of the furrows should commence at the point furthest from the latrines and it should gradually come nearer to them. The earth removed from the first furrow

should be wheeled down near the latrines, where it will be ultimately wanted to cover the last furrow which is dug. The capacity of the furrow or little trench will depend upon the size of the spade. I find that, working in ordinary garden soil with a spade having a blade nine inches long and seven inches wide (the furrow being consequently nine inches deep and seven inches wide), eight stable-bucketfuls of soil each holding two and a half gallons, or about twenty-two pounds weight of earth, were removed. This amounts to two and a half bushels of soil, weighing 176 pounds, as the measure of the capacity of a trenchlet eight feet long. This trench must be filled with excreta, and great care must be taken that nothing except fæces and paper and the accompanying urine is placed in it. If broken crockery or old tins are accidentally mixed with the excreta they must be removed. The trench being filled with fæces, mark out a digging line at a distance equal to the width of the spade (seven inches) behind the edge of the first trench and then cover the fæces in the first trench by the earth removed in making the second. Owing to the draining away of urine and moisture and their great compressibility it will be found that the excreta undergo a considerable diminution of bulk when tipped into the trench. When the earth of the second trench has been removed and shovelled on to the top of the first trench it will be found that there is a raising of the general level of the ground, and the second trench will be found to have a cross section which is rather triangular than rectangular, owing to the oblique direction of its front wall, which is composed of a sloping bank of friable earth. The surface of the ground must be left crumbly, smooth, and perfectly neat, like a well-prepared garden bed. No particle of fæces or paper

must be left uncovered. There will be no offence to eye or nose, no putrefaction is possible, and the fæces are beyond the reach of dipterous insects, and if there has been no delay in the collection and burial of the fæces they cannot have been used for oviposition to any great extent, so that the soil will not become infested with 'grubs.'

How many men will provide the quantity of fæces which can be placed in a trench eight feet long from which 176 pounds weight of earth have been removed? The answer to this question is governed by bulk rather than by weight. If fæces and earth were equal in bulk for equal weights and if we allow a quarter of a pound of fæces for each man—for the urine soaks away and *qua* bulk may be neglected—then the answer would be $176 \times 4 = 704$. If the fæces are weight for weight four times as bulky as the earth, the answer is 176. In any case it seems safe to say that a trench eight feet long, nine inches deep, and seven inches wide will suffice to take the fæces of 100 men. This estimate entirely accords with my experience gained in my garden at Andover, where the fæcal accumulations of twenty cottages have been disposed of daily in the manner indicated for eighteen years, and where it takes at least five years to cover an acre of ground in this way. Those who have not had experience of this method of dealing with fæces are apt to have exaggerated views as to the amount of land required. If a trench eight feet long and seven inches wide is sufficient for the disposal of the daily quota of excreta from 100 men, then ten such trenches occupying an area of eight feet by seventy inches—say six feet—is enough for 1,000 men, and one strip of ground fifty yards long and eight feet wide would serve for a regiment of 1,000 men for twenty-five

days, and the sixteen strips would serve for 400 days—let us say half an acre per annum per 1,000 men. The actual area necessary will depend to some extent upon the nature of the soil and the care and skill of the scavenger, but in no case can the area required be regarded as a bar to the process—certainly not on the Veld or on Salisbury Plain. It need not be insisted on that a scavenger must be incessantly at work. The excreta should be taken up as soon as dropped and be placed in a covered pail, and the pail when full should be emptied into the furrow and covered up. In this way effluvia are stopped and ovipositing by diptera is rendered impossible. Further, this method of disposing of fæces necessitates no increase of the impedimenta of an army; no lime or chemicals are needed, and no apparatus beyond a spade and a set of garden tools.

The ground beneath which the fæces are deposited should when the work is done have the appearance of a well-prepared garden bed and it will need little attention until it is covered with herbage of some kind. The only question remaining to be decided is as to what that herbage should be. There can be no camp without water-supply, and in every camp one of the sanitary problems is the disposal of waste water. Some of this waste water should be used in time of drought for laying dust and encouraging fertility in that small area of ground beneath the well-tilled surface of which the fæces are safely bestowed. Then, the higher the temperature the quicker will the ground bring forth green leaves to freshen the air. Whether the crop be grass, cabbage, cereals, onions, mustard and cress, lettuces, spinach, or what not must depend upon circumstances. I think the seeds sown in such ground should always be those of culinary vegetables, which

may prove a real blessing if the camp be long occupied. With a little care in a hot climate one may have a green covering of grass or mustard and cress in a week, which at least will give off oxygen to the air even if it do not serve as an antiscorbutic diet for man and beast—a diet which may just supply that something which is lacking in tinned and salted provisions.

In a temporary camp these methods of excrement disposal are the best on the grounds of immediate hygiene. In places like Salisbury Plain, which are to be used as camping-grounds year after year, latrine gardens are essential, and, if properly managed, should furnish a good many acceptable extras for the canteens. In 1900 at Perham, on Salisbury Plain, there was a field of many acres occupied by the scavenging contractor and placed a few hundred yards from the camping-ground. On this were piled heaps of camp refuse, old tins, meat bones, broken victuals, packing materials, and fæces which had been 'dumped' with a view to burning when dry enough. In their recent state these heaps (in which flies were swarming) could be smelt for a quarter of a mile down wind, and when they began to burn the offensive smoke drifted still further and not seldom over the camps themselves. This haphazard method of 'dumping' refuse in pestiferous heaps is not economical, not even from the point of view of the area of ground required, and would be rendered unnecessary by a little care in collection and the judicious use of the spade by men who knew how to turn these despised materials to profitable account. Horsedung in the same way should be neatly stacked in heaps like hotbeds, protected at the sides and covered with earth. In this way the flies would be prevented

from feeding and egg-laying on the dung, large quantities of saladings might be produced, and when the camp was moved this well-rotted material should be applied to the camping-ground with a view to the renovation of the turf. On Salisbury Plain the growth of summer is trodden under foot and there is no systematic renovation in the winter. On turf downs the actual camping-ground should be changed every year and the ground 'top dressed' as soon as the camp breaks up in the autumn. Without careful management and good husbandry these downs will soon be trampled and scuffled into a dusty wilderness. In the same way all the kitchen refuse should (after utilisation to a maximum extent in the stock-pot, &c.) be neatly stacked, protected at the sides, and covered with earth. All organic refuse should be completely protected by soil from the attacks of diptera, and its fertilising properties should be utilised forthwith.

It is sometimes said that we ought to be ready to forgive the house-flies for the annoyance which they cause to us because of their great services as scavengers; but I am rather inclined to take the view that the presence of flies is a reproach to us for not putting organic refuse to its proper use, and that the fly is a robber which has been bred in material which we have deliberately allowed to lie above ground instead of covering it with soil. The scrupulous sweeping up of crumbs and food particles immediately after meals and the instant removal of the remains of food to fly-proof larders need not be insisted upon. I believe that a great advance in domestic hygiene will have been made when the custom is more general of removing dung every day from our stables, piggeries, cattle-sheds, and poultry-runs, and stacking it carefully so as to

prevent the access of diptera, or burying it immediately beneath the surface of well-tilled soil with a view to the production of crops. We pity the horse 'turned out' in a paddock when we see it tormented with 'flies.' Few of us pause to think that if the horsedung had been collected daily and put to more profitable use instead of being allowed to lie about and generate a plague of flies the animal might have been happier and the dung might have been more valuable for fertilising purposes. When flies breed in dung-heaps the larvæ eat the dung and leave the straw. If each fly needs one grain only of sustenance then the 25,000,000 which I have stated as the possible season's progeny of a female house-fly will be capable of robbing a farmer of 25,000,000 grains of fertilising material, which at 7,000 grains to the pound works out at 3,571 pounds, or considerably more than one and a half tons. It is bad economy to have your scavenging done by flies and sad to see your potential wealth make to itself wings and fly away. In my garden at Andover where human excreta have undergone daily superficial burial for about eighteen years there is no excess of flies, and I have come to the conclusion that an essential part of garden management is the daily collection of all garden offal, such as dead leaves, fallen and rotten fruit, &c., and either superficially burying or stacking it so that it shall not serve as a breeding-ground for insects which often prey upon the plums and peaches in the autumn.

In the management of refuse I am no advocate for the use of chemical disinfectants. These are expensive, generally evil-smelling, often poisonous, and lead to an increase of material to be transported. The soil is quite capable, with proper management, of turning all organic refuse into 'soil'—a fact which the experiments of Sir

Seymour Haden and myself have abundantly proved. Our experiments have also shown that from the point of view of the innocuous transformation of organic refuse into 'soil' deep burial is a mistake. This is true alike of dead animals and of excreta. We are happily hearing less of the pollution of the earth and of the growth of microbes and toxins in the soil, and even from the laboratories of bacteriologists we are learning that the soil is our best friend. The use of quicklime in the treatment of excreta is, I believe, quite unnecessary. My experiments in burying small animals tend to show that the quicklime preserves the body and mischievously prevents the beneficent action of the soil. In the management of refuse, there must be no slovenly 'dumping.' What is wanted is proper sorting at the time of collection, great attention to detail, absolute neatness, and an appreciation of the ends to be attained.

In recommending the immediate collection of all organic refuse and its instant covering with earth, I am making no new recommendation. Moses had had experience of a 'plague of flies' in Africa and was no novice in the matter of camp-management. He found it necessary to be most explicit in his directions for the treatment of excreta. These directions are given in Deuteronomy xxiii. 12–14, and I find that in the Revised Version of the English Bible there is an interesting change in the passage. The old version runs thus:

'Thou shalt have a place also without the camp, whither thou shalt go forth abroad:

'And thou shalt have a paddle upon thy weapon; and it shall be, when thou wilt ease thyself [sittest down] abroad, thou shalt dig therewith, and shalt turn back and cover that which cometh from thee:

'For the Lord thy God walketh in the midst of thy

camp, to deliver thee, and to give up thine enemies before thee; therefore shall thy camp be holy: that he see no unclean thing in thee [nakedness of anything], and turn away from thee.'

The new version says (verse 13): 'Thou shalt have a paddle *among* thy weapons,' and as a variant for paddle gives 'shovel' in the margin. The passage, therefore, means that a shovel for burying excreta immediately is a necessary implement in every camp.

CHAPTER II

AN EXPERIMENT IN SANITATION—COLLECTION OF RAIN-WATER—DISPOSAL OF SLOP-WATER[1]

This cottage is represented (*see* fig. 1) not because of any architectural beauty, but because it presents points of interest. It forms the lodge of Gallagher's Copse, which is a mile from Andover Junction, just outside the borough boundary. The borough having recently adopted the Model By-laws of the Local Government Board, it became necessary to trek over the border in order to escape from possible hindrances and prohibitions—an important matter, because the owner is, in the matter of house-building, an experimentalist. The soil is chalk. The foundations were laid out by the aid of a compass, in order to ensure that one angle of the cottage should point due north. This arrangement ensures that there is a possibility of some sunshine upon every wall of the house at every season of the year. The accommodation consists (*see* fig. 2) of a living-room (L), three bed-rooms (B, B, B), scullery and wash-house (S), glazed verandah (V, V), earth closet (C), wood-house (W), and rain-water tank (T).

In the house it will be noticed that there is a door front and back, so that the passage can be swept by a thorough draught; that no room communicates directly

[1] Reprinted from *Country Life* of July 6, 1901.

with any other room; and that every room has a fire-place, which, from the point of view of ventilation, is most important. No fireplace is placed against an outside wall. The chimneys do not get chilled, and 'draw' admirably.

This cottage contains what ought to be the minimum accommodation, viz. a living-room, and a bedroom each for parents, boys, and girls. The scullery and wash-house is so placed that, although it can be reached under cover, the smell of cooking and the steam of washing need not invade the dwelling-house. The earth closet is well removed from the rooms, but, nevertheless, can be reached under cover, *via* verandah and wash-house. The walls are built of 'mud,' with rough-cast on the outside. Mud (*i.e.* chalk puddled up with a certain proportion of straw), flints, and timber are the only building materials found in the district. Most of the clay-pits in the immediate vicinity have been long worked out, and there is no stone. Mud is a non-conductor of heat, and is consequently a very warm material. It is said in the district that frozen water-pipes are very uncommon in mud houses. It is very lasting, provided it be kept dry. Mud walling should be begun in March, and should not be carried on after the beginning of September. It is not advisable to hurry your operations. Foundations are necessary for mud walls, and these should be of flint, concrete, brick, or stone. The mud is 15 inches thick, and with rough-cast on the outside and a lining of match-boarding the thickness of the walls is about 17 inches, and the fireplaces being all in the centre and every side exposed to the sun, it is needless to say that the cottage has proved a very snug winter residence. The floors are of concrete, finished in granite cement, and the skirtings are of the same material.

Fig. 1.—View of Cottage.

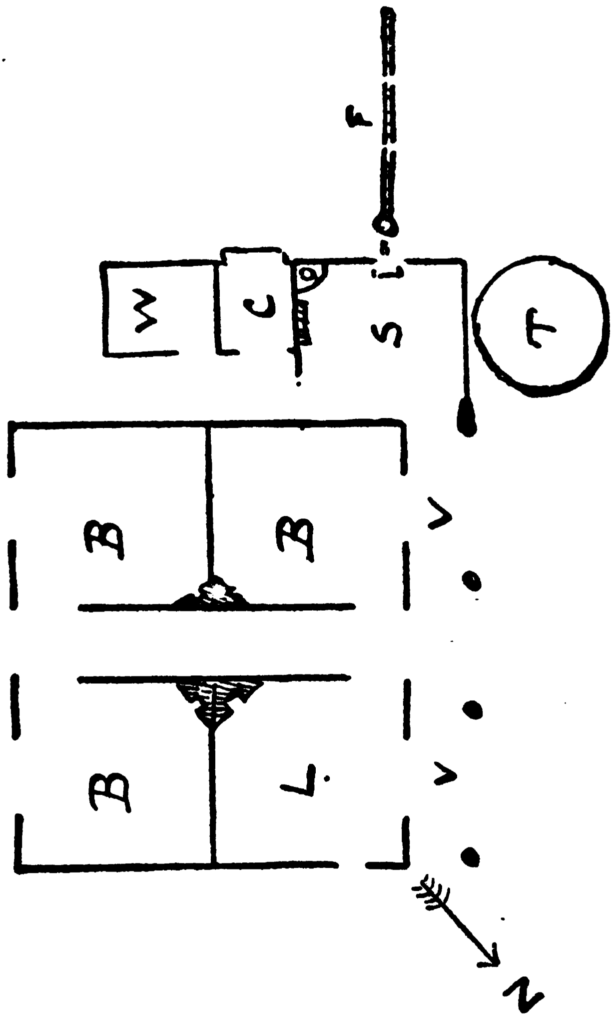

FIG. 2.

Plan of Cottage: L, living-room. B B B, bedrooms. S, scullery. C, earth-closet. W, wood-house. V V, verandah. T, rain-water tank. F, slop filter and filtration gutter.

Mud walls are inexpensive. The price paid for the walls of the above cottage was 5*s.* per perch, *i.e.* a piece of wall 1 foot high, 15 inches thick, and 16½ feet long.

The Model By-Laws of the Local Government Board say that the walls of a dwelling-house must be of hard and incombustible material bonded together with good mortar or cement. Now as mud is not hard, contains straw, and is not bonded with anything, it is doubtfully by-legal in districts which have adopted these Model By-laws. In the late fire at Andover it was found that while the thatched roofs blazed, the old mud walls of the cottages withstood the fury of the flames. When the tendency of by-laws is to boycott a local building material and to extinguish a local industry, the *pros* and *cons* ought to be very carefully considered.

An interesting feature of this cottage is the rain-water tank. Although I have a deep well close at hand which supplies an abundance of pure water, I was anxious to ascertain how far rain-water falling on the roof was capable of being utilised for household purposes, notwithstanding that in some districts of England cottages which are dependent upon rain-water only are not permitted. With this end in view, I was careful to provide a very plain, simple roof, without recesses for the lodgment of dirt or nests, and it was this which led me to use slates as a roofing material in preference to the more picturesque tiles which grow moss. My rain-water tank is constructed on the principle of the Venetian cistern. In a city which reached the highest pinnacles of commercial and artistic supremacy on 'rain-water,' one is tolerably sure to get valuable ideas for the collection and storage of that commodity. The Venetian cistern is of large capacity, and is so arranged that all water drawn from the central well has previously passed

through a sand filter. The tank is circular in form, having an internal diameter of 7 feet and a depth of 10 feet. It is divided down the centre by a diaphragm, which is perforated at the bottom by three agricultural drain pipes. Each half of the tank contains 3 feet of filtering material consisting of (from above, down) 1 foot of coarse gravel, 1 foot of fine gravel, and 1 foot of sand. The rain-water which falls from the roof passes through two strainers contained in an ornamental vase, and then, before being pumped, passes down through 1 foot of coarse gravel, 1 foot of fine gravel, and 1 foot of sand, and up through a similar filter, before it can be drawn from the pump. The tank is constructed entirely of cement concrete, and the pump has a copper suction pipe. It was important to avoid the use of lead, iron, or galvanised iron for the storage of rain-water intended for dietetic purposes. It will be noticed that all the water has to be raised by a pump, so that none of it can accidentally run to waste. The drips from the pump are conducted back into the unfiltered half, and should a boy play with the pump, he will merely ensure a double filtration for the water, and will not be able to waste any of it. I believe that half the water which we are supposed to 'use' is merely wasted by carelessness and bad taps. It will be noted that the water tank has been brought to the front of the house, and that an ornamental vase has been used for conducting the water from the roof. Anything amiss with the water tank will be noticed at once. This seems better than a dirty water-butt in an obscure corner. Those who have more money and taste will, I hope, soon outdo me in this direction. I commend the rain-water tank to the attention of architects.

It may be well to dwell for a moment on the powers of this roof as a rain collector. The area of the roof is

(approximately) 1,100 square feet, and if the annual rainfall fluctuate between 24 inches and 30 inches, then the amount of rain falling upon the roof will vary from 2,200 cubic feet to 2,750 cubic feet. If we take a cubic foot as the equivalent of 6¼ gallons, then we may say that the amount of rain annually falling on the roof will fluctuate between 13,750 gallons and 17,187 gallons. If we put the average water-supply of the roof at 15,000 gallons a year, or rather more than forty gallons a day, we shall not be far wrong.

Water experts say that in towns we want a supply of forty gallons per head per diem. The dweller in the clean country is content with much less than this, and I feel convinced that ten gallons a day is an extravagant estimate for the daily supply of a perfectly clean peasant who does clothes-washing at home, but has not the power of wasting water.

The storage capacity of the tank is about 1,600 gallons, or forty gallons a day for a drought of six weeks. The water is excellent, odourless and colourless, and altogether very unlike ordinary rain-water.

The water of this cistern was analysed both chemically and bacterioscopically for the Royal Commission on Sewage Disposal on November 14, 1901, and with the following results:

Parts per 100,000 by weight.

Ammoniacal nitrogen		0·064
Albuminoid „		0·020
Nitrite		0·033
Nitrate		0·086
Oxygen absorbed from permanganate at 80° F.	at once	0·28
	after 4 hours	0·48
After incubation at 80° F. for 6 days	at once	0·28
	after 4 hours	0·79
Combined chlorine		0·16
Dissolved oxygen (parts per 1,000 by volume)		2·8

'Sample clear but yellow, no sediment, peculiar faint smell rather like soot.'

The above is a typical analysis of rain-water. To the eye and palate it is the best sample of rain-water I have ever seen, and it has been used for all domestic purposes. It should be said that the yellow colour is very slight. Personally I cannot detect any smell, but there is a faint taste of terra-cotta.

Dr. Houston found 25 bacteria per c.c. on gelatine at 20° C., and 7 per c.c. on agar at 37° C. The tests for Bacillus coli and Bacillus enteritidis sporogenes gave negative results.

These analyses are full of instruction, and show how chemistry and bacteriology are needed to check each other, and how both need to be checked by a knowledge of source and circumstances.

The disposal of slop-water is always an important consideration in cottage management. Usually this means slop-water plus roof-water, but in this cottage the roof water has been provided for. The amount of slops, allowance being made for evaporation in cooking, and washing and drinking, must always be considerably less than the water consumed. Economy in the use of water lessens the slop difficulty.

In this instance the slops are strained and filtered, and allowed to flow away in a 'filtration gutter,' to be presently described. The arrangements are on the south side of the cottage, well exposed to the sun, so as to favour evaporation.

The sink is just beneath the window of the scullery, and the waste-pipe, without trap of any kind, passes through the wall, and terminates in a free end about 18 inches from the wall and 2 feet 6 inches above the

level of the ground. The waste-pipe empties itself into a strainer and filter, which are placed about 15 inches from the cottage wall, so as to avoid the risk of splash or back soakings or accumulations of 'dirt' and insects between the wall and the filter. The strainer is placed on the top of the filter, and the filter discharges its water on to a filtration gutter. This filter is shown in fig. 1 at the extreme right, and is marked with a cross. A longitudinal section of the arrangement is shown in fig. 3.

The strainer consists of a basket with a wisp of straw in it (B). This arrests all but the finest particles, and is the best fat-trap I know—the only one, in fact, which does its work efficiently and without offence. The straw may be changed as often as necessary—every day, once a week, once a month, according to the amount of accumulations, which will largely depend upon the thriftiness and knowledge of the cook. The contents of the strainer may be given to the chickens, put on the manure heap, or burnt. A new handful of straw is then put in and the strainer replaced. The changing of the straw has the advantage of giving a new direction to the water. Any old basket of suitable size which will hold the straw answers the purpose of a strainer. After months of use it will get greasy and rotten, and may then be burnt and be replaced by a new one. From the strainer the slops flow into the filter, which is simply a galvanised iron vessel, with an outlet at the bottom and filled with broken clinker varying in size from peas at the bottom to walnuts at the top. This filter effects a further purification of the slops, and acts partly mechanically and partly by virtue of the growth of bacteria, on the surface of the broken clinker. The filter shown has been specially constructed, and is duplicated (*see* fig. 4), and the waste-

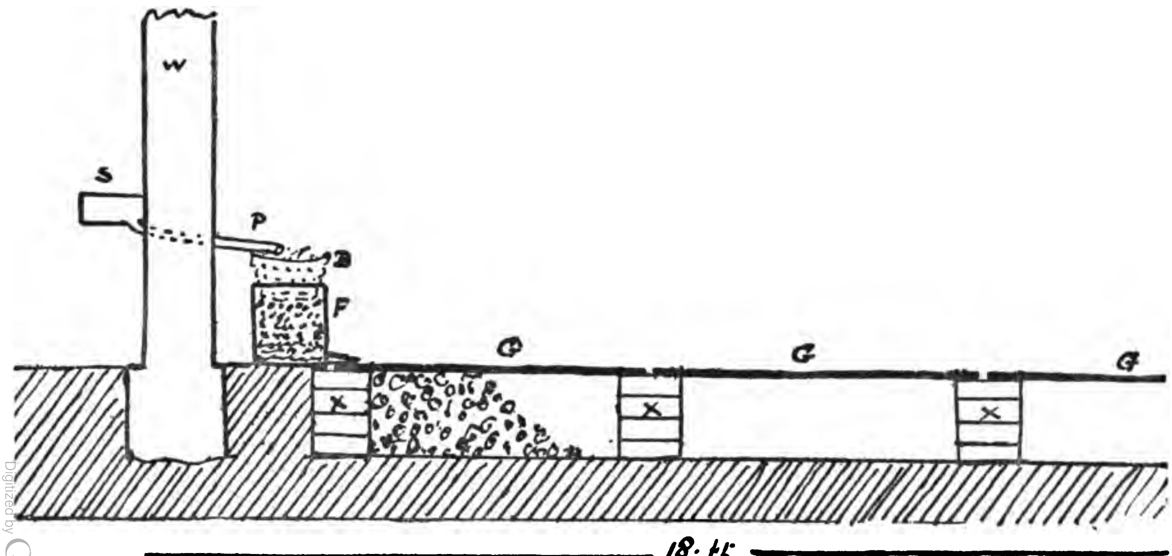

FIG. 3.

S, sink. W, wall of cottage. P, waste-pipe. B, basket containing straw. F, filter. G, cast-iron filtration gutter, supported in trench by (X) columns of bricks on edge.

pipe of the sink is provided with a reversible nozzle so that either half of the filter can be used. For a cottage, however, this is not necessary, and an old galvanised iron bucket with a hole in the bottom will be found to answer every purpose.

The filtration gutter consists of strong cast-iron guttering, perforated with conical holes, having the small ends upwards so that they cannot get jammed (*see* fig. 5). This guttering, which is 9 inches wide and in lengths of

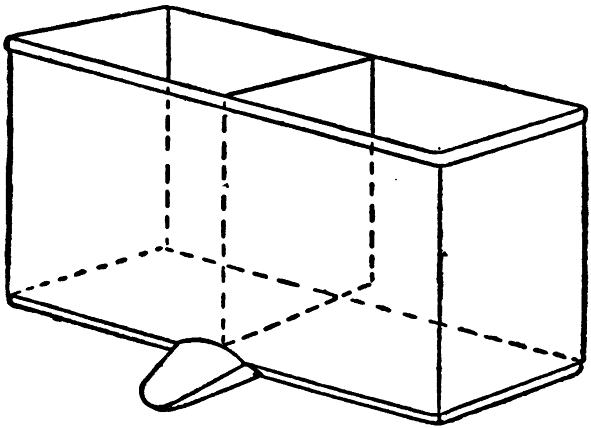

FIG. 4.—DUPLICATED TANK FILTER.

6 feet, is laid upon loose porous rubble or gravel placed in a trench.

A trench 18 inches wide and 18 inches deep was first dug from the filter due south, care being taken that the bottom of the trench should slope away from the cottage, in order that water should not flow back towards the foundations of the building. The lengths of guttering are then laid on a level with the top of the trench, the level being maintained by means of bricks on edge, built

up without mortar in little columns of four from the bottom of the trench, each column, except the first and last, serving to support the ends of adjacent lengths of

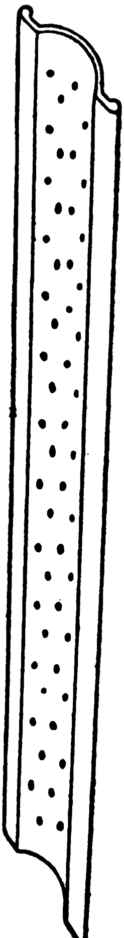

FIG. 5.—FILTRATION GUTTER.

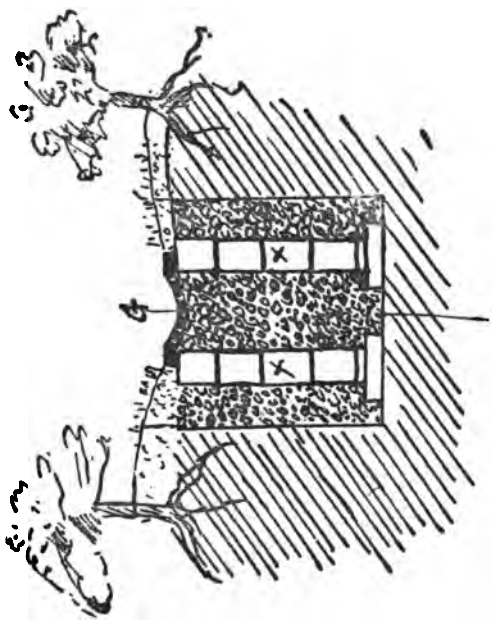

FIG. 6.

G, cast-iron filtration gutter supported on bricks on edge (X). T, trench 18″ × 18″ filled with coarse rubble.

guttering. It being ascertained that the level of the guttering is true, with the slightest possible slope downward from the filter, the trench is finally filled with loose rubble of any kind—builders' rubbish, burnt clay, lumps of chalk, gravel, clinker, coke, whatever may be most readily obtained. This arrangement is shown in longitudinal section (fig. 8) and in cross section (fig. 6). Care should be taken that the packing be accurately done at the junctions of the lengths of guttering, in order to give support and firmness to the brick supports. When finished, the filtration gutter looks as though it had been simply laid upon the ground, there being, of course, no indication of the rubble-filled trench beneath it. The iron guttering is sufficiently strong to permit a wheelbarrow or cart to pass over it, and there is no objection to taking the gutter across a path. The sides of the trench should be planted; or the trench may be dug in a shrubbery or plantation. At the cottage in Gallagher's Copse the trench is taken across the garden, and the sides are planted with raspberries and black currants.

The arrangement shown has been in use since September 1900. The straw in the basket has been changed about once a fortnight. The filter has never been changed; we have never seen the slops run further than the end of the first length of guttering, and when the slops are not running the gutter and its neighbourhood looks perfectly dry. There is absolutely no smell, no offence to eye or nose. The length of gutter provided is 24 feet (four lengths), but the water has never been seen to travel more than 6 feet.

Next, as to expense. The guttering has been made for me by Messrs. Tasker, of the Waterloo Iron Works, Andover, and costs 1*s*. 6*d*. per foot run, and the special

duplicated slop filter was supplied by the same firm at a cost of 27*s*. 6*d*. The total cost, therefore, of draining this cottage was as under:

	£	s.	d.
Labour for digging trench, &c. . .	0	2	6
Basket	0	0	9
Filter	1	7	6
Four lengths of filtration gutter (24 feet in all)	1	16	0
Forty-eight old bricks, clinkers, &c., say	0	1	0
	£3	7	9

But if an old basket and an old galvanised pail be employed, and if two lengths of guttering be used instead of four, then the above bill will be reduced by 2*l*. 6*s*. 3*d*., leaving 1*l*. 1*s*. 6*d*. as the total cost for providing drainage for the cottage. Not only does the filtration gutter allow the slop-water to flow away, but it stops back dead leaves, which otherwise would soon choke the porous rubble in the trench.

I may say that I advise that nothing but open guttering be used for slop-water, be it perforated or otherwise. Wherever this putrescible mixture flows in the dark, the faint smell of drains is soon perceptible. Where all is open, those little accidents which proverbially will happen are seen at once.

Finally, the construction of the earth closet demands a few words. Its precise situation and the reasons for it have been previously alluded to. The closet is lighted by a skylight, and air is freely admitted everywhere, both in the closet and beneath the seat—a point of very great importance. The receptacle is capacious, and is in the form of a 'dry catch,' as described in 'Rural Hygiene' and 'The Dwelling-house.' The seat is only 14 inches high. The earth is contained in a bin fed

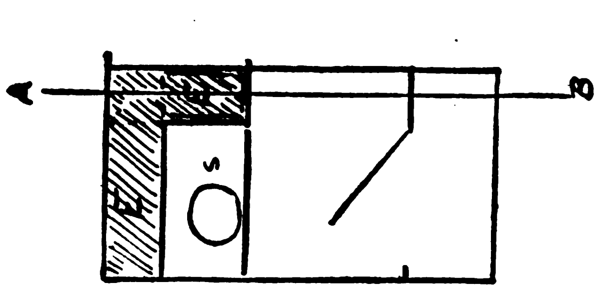

Fig. 7.

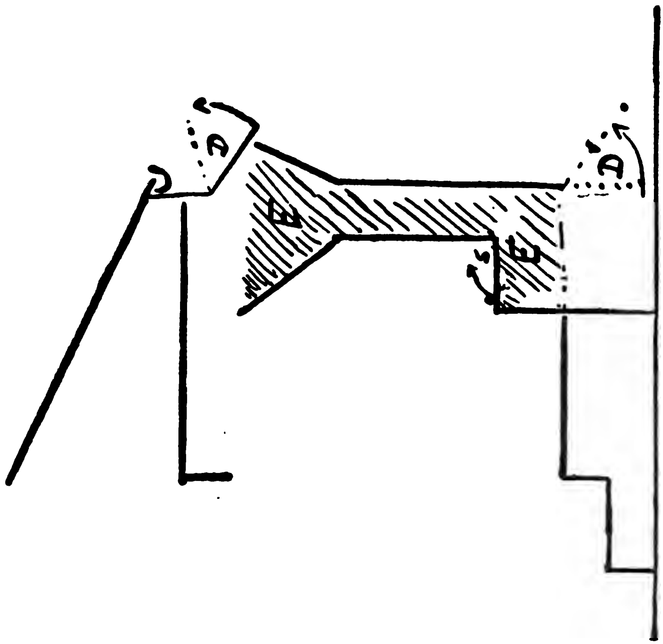

Fig. 8.

Earth Closet.—Fig. 7, plan. Fig. 8, vertical section through A–B. E, earth bin and hopper. S, seat. D, door for filling hopper. D', door for removing soil.

from a large hopper-reservoir, which holds enough earth for about 1,000 uses of the closet. The earth is added by means of a hand scoop. The earth box is filled, and the soil is removed, from the outside. In the illustration (fig. 1) the lid of the hopper, through which the earth is supplied, is plainly visible. Figs. 7 and 8 show a plan and a vertical section.

The following are the main principles to be observed in the construction and management of earth closets.

1. The earth should be stored in a bin, and be thrown on the excreta with a scoop. A disused packing-case placed alongside the seat will serve every purpose.

2. The excreta may be received in a bucket or allowed to fall into a 'dry catch.' They should be removed every day if possible.

3. There must be free ventilation beneath the seat, so that it may be possible for effluvia to escape elsewhere than into the closet. The absence of such ventilation is one of the common defects in earth closets. The provision of such ventilation causes draughts. For delicate persons a shutter must be provided to be closed when necessary.

4. The bucket or excreta should be removed from behind, the opening being closed by a wire guard (about as stiff as a fire-guard) to prevent the access of dogs or vermin.

5. The larger the amount of earth which can be stored in the bin the better. The constant need of replenishing the earth-bin is a great and serious drawback. The amount of earth remaining in the bin should be always visible, so that its replenishment may be provided for. It is quite easy to provide a bin which will hold a ton of earth.

6. The bucket must be cleaned by emptying, scraping,

and finally dusting with dry earth; and a little earth should be thrown in before it is replaced. It must not be washed or whitewashed.

7. An earth closet attached to a house should be highly finished and be well lighted and ventilated, and should be so constructed that the bin may be filled and the excreta removed from the outside.

8. A seat supported at either end by an old packing-case in which earth may be stored is an excellent make-shift.

9. This may be covered by a rough shed or tent.

10. No antiseptics should be used. They poison the earth and destroy its manurial value.

Dry Urinals

Earth, sand, peat, sawdust, or any other dry and absorbent material exercises a purifying influence on urine which is allowed to filter slowly through it,[1] and there are circumstances when such urinals may be very useful.

They are admirably suited for use on race-courses, cricket and football grounds, and other places where people congregate occasionally. On my advice they have been placed on two cricket grounds near London, and have given great satisfaction; they have been used also in the engineers' yard attached to the Twickenham Station of the London and South Western Railway, which is visited by a large number of men (averaging perhaps 150) every day, and the South-Western Railway have fitted them up at one of their country stations.

Again, in country houses a urinal for gentlemen placed in some accessible but secluded spot, and formed

[1] See 'The Dwelling-house,' pp. 49 *et seq.*

of a basket or barrel of convenient height filled with peat or sawdust, will be found both economical and inoffensive. In the garden of a little cottage I have such a urinal, consisting of a small barrel filled with peat, which has been in use for nearly eighteen months, and which has never been changed, and is yet perfectly free from offensive odour. It is only when the top layers are removed that the nose perceives an ammoniacal odour, and then only when placed almost in contact with the peat.

I am accustomed to advise that such urinals for public use should be in the form of troughs made of basket-work or hurdling, or of wood panelled with perforated zinc, the trough to be triangular in section, with apex downwards, 3 feet 6 inches wide at the upper part, and 2 feet 4 inches in depth.

The shape of the trough and the material of which it is made facilitate evaporation. Such a trough should be under cover to prévent the access of rain, and it is obvious that with a width of 3 feet 6 inches it might be used from either side, provided a match-board screen were placed vertically along the centre (see fig. 9).

Allowing 2 feet of length for every 'place,' it follows, there being a 'place' on either side, that each foot of length would afford one place.

It might be necessary to allow the wicker-work trough to have an open gutter beneath it, but it is only exceptionally that any effluent would be afforded.

If such a trough is in constant use the sawdust must be turned over and stirred occasionally, and if this be done it will never be foul, and the sawdust can be used for surprisingly long periods of time without emptying.

If sufficient sawdust, or peat, or dry earth be pro-

vided for a double charge, so that one charge may be drying in a shed while the other is in use, my belief is that this might be used for indefinite periods.

A final question, and one of very great importance, is the ultimate destination of the absorbent material.

Sawdust has a very bad reputation with agriculturists, who assert that when used in large quantities it grows fungi and poisons the land. If fresh sawdust be used, and if it be employed in relatively large quantities,

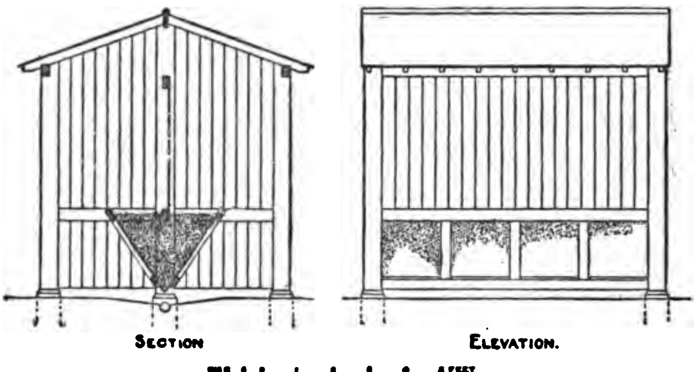

FIG. 9.—DRY URINAL.

and especially if it be buried too deeply, I can well understand that it would prove prejudicial to crops.

I can positively assert, however, that deal sawdust or peat, after being soaked with urine, shows no disposition whatever to become mouldy. I have never seen mould upon deal sawdust, but I have seen it upon oak sawdust.

My experiments further show that when sawdust or peat has been used as a top-dressing good crops have followed, whether on grass or garden ground. The

cricket clubs which have, in accordance with my advice, put up dry catch closets and dry urinals have used the products as a top-dressing at the end of the season, and with the result that their wicket pitches have been the envy of their neighbours. The dressing must be thin or the sawdust or peat should be passed through a riddle and diluted with soil before application. If too thickly applied it will 'burn' the grass like pure guano.

Chemists tell us that urine is of high manurial value because of the large amount of nitrogen which it contains. This is doubtless true, but we all know that the immediate effect of pure urine is fatal to herbage. Whether this be due to the heat of the fresh urine or the salts I do not know, but I fancy the latter. In the same way we know that a sprinkling of salt, or salt and water, kills weeds; but we are told that salt is a bad weed killer, because it ultimately acts as a manure, and causes increased growth. Now urine does the same thing.

The farmer who uses the urine and dung of his animals mixed with absorbent material (generally straw), and ultimately places it on the land as a top-dressing, gets nothing but good from it.

The practices I advocate are exactly analogous to those which have been used by agriculturists in every age, and with the best results. I am merely advocating a return to customs which have been tried again and again and have never been found wanting.

In the 'Journal of the Royal Agricultural Society' (vol. vii., part iv., December 1896) I find a statement (p. 631) that in the delta of the Nile a compost of earth and cattle urine is generally used as a manure.

'Owing to the lack of wood, the people are compelled, as in India, to use the solid droppings of their cattle as

fuel, but they conserve the urine on a very ingenious system. Loose earth, shifted and renewed from time to time, is used as a covering for the stable floor, and earth is so much in demand for this purpose that the irrigation officers can hardly prevent the people from carrying away the canal banks.' Analyses show from 1·25 to 2·5 per cent. in equivalent of nitrate of soda. It is obvious, however, that a chemical analysis gives but a poor idea of the value of the compost. It is applied at the rate of eight tons to the acre for growing sugar and maize.

Housing of Animals

In country places and in connection with country houses provision has to be made for the proper housing of animals.

Speaking broadly, there can be no doubt that the more fresh air we give our animals (the more they are in the open and the less they are under cover) the better.

Sheep are rarely housed, unless it be with a view to their getting prizes for being in a condition of diseased obesity.

On Mr. Stephens's farm at Cholderton one may see not only sheep, but herds of cattle and numerous brood mares and foals, all in the rudest health, notwithstanding that they never go within doors from year's end to year's end.

It is the same with poultry. If they are to be kept healthy they must be confined indoors as little as possible. 'Who,' says Cobbett, 'can get up as early as the birds?' and it must be remembered that birds are out nearly an hour before sunrise all the year round. If poultry be locked up, with a view to forcing egg-

production by keeping them warm, it is probable that they will become tuberculous.

Sir Frederick Fitzwygram, in his exhaustive treatise on the Horse, is very careful to insist on the perfect ventilation of stables, and tells us of certain London cab. stables where the health of the horses became excellent after the doors and windows were removed.

In the construction of stables Sir Frederick Fitzwygram insists on the danger of underground drains, and advises that the drainage of a stable shall be by open gutters only, and that these gutters shall lead to gullies removed many yards from the stable door. This is rational common sense, and must be applied not only to stables, but to human habitations also.

Trapped gullies are only miniature cesspools, and the presence of such contrivances within stables or cow-houses means that the animals are breathing the gases of putrefaction whenever they are within doors.

It is a question whether in such places we do not often go to a huge expense in order to do things wrongly.

I call to mind three cow-houses which I visited in the autumn of 1895. One was at a very old-fashioned manor-house near Alresford, Hants, and was a high-pitched, thatched, barn-like building, which had been used for cows 'time out of mind.' There was an open door at either end; the floor of the stalls was of beaten earth, and the middle passage between the stalls was of flint pitching. The stalls had a very slight slope from head to tail, and there was no drain of any kind, and no water-tap for the adulteration of the milk or the 'swilling down' of the building. The dung was removed every morning with shovel and besom, and, if necessary, some earth was thrown upon the floor of the stalls. This house was fragrant, and filled with the

sweet breath of kine and the aroma of good upland hay. There was no suggestion or suspicion of foulness. The urine in this case must have soaked away to a great extent into the earth and between the pitching, and had done so in this place, perhaps, for centuries.

The other two cow-houses were of a different order. One was at an establishment devoted to giving technical instruction in dairying, and the other belonged to a milkman in a country town. Both had cost much money, with impermeable bricked floors, water-taps for swilling down, and drains within the building for carrying away the valuable dung and urine. They were both damp, with water lying between and in the grooves of the bricks, and both had a sickening smell of putrefaction. Neither of these last two cow-houses was desirable place in which to collect milk. I have little doubt that the Bacterium coli, which lives in water, was very abundant in both of them.

Water (unless it be boiling hot and used with abundance of soap and a scrubbing-brush) is entirely out of place in cow-houses, dairies, and butchers' shops.

Putrefaction is easily attained by swilling with cold water. Real cleanliness is unattainable in this way.

The dung and urine of all domestic animals is invaluable for the farm and garden, and it all ought to be carefully preserved. I feel that the best way of doing so would be to allow the stalls of stables, cow-houses, piggeries, &c., to have a very gentle slope to a gutter or trough filled with absorbent material, such as earth or peat moss, and protected by a grating. This trough would be cleaned out whenever it became in the least offensive, and thus the whole of the urine would be saved for the farm.

It needs hardly to be said that all animal houses

must be kept scrupulously clean. There must be no accumulations of dung, and all such ordure must be removed daily. The besom and shovel and wheelbarrow are the only proper tools for doing this.

If 'water-carried sewage' be introduced on the farm the ruin of the farmer is more certain than it is at present.

Construction of Wells

It is admitted that humus is one of the best filtering materials for water, and that water from a river full of living organisms is to a large extent freed from them by filtering through a few feet of the humus on its banks. In the past few years Sir E. Frankland demonstrated that water of singular microbial purity could be obtained from the gravel beds which in places flank the Thames. Such water, one must suppose, is obtained from ground water which has fallen upon the earth, has filtered through it, and is slowly flowing towards the river. The purifying agent in these cases is mainly the living humus which lies upon the surface, although the subsoil cannot be without some effect. These facts must alter our attitude towards surface wells, and must teach us what to a great extent has been admitted—that the purity of surface wells must depend more upon the mode of construction and the surroundings of the well than upon its depth. Wells are polluted by foulness which has reached the subsoil without being subjected to the purifying influence of the humus; and there are many facts which go to show that if foul water gets to the under side of the humus without going through it its purification in the subsoil is far from certain. The Lausen epidemic, the Worthing epidemic, and the pollution of the deep well sunk in the sandstone at Liverpool,

seem to show us that percolation through a mile of underground strata entails no certain purification, and that wells 80 ft. or 400 ft. deep are not safe if fissures allow the contents of cesspools, leaking under pressure, to trickle into them. The almost universal condemnation of surface wells and their frequent pollution are mainly due to the fact that we take our filthy and dangerous liquids through the humus in pipes, and thus ensure at great expense that they cannot be subjected to purification by it. If these underground pipes leak, the mischief caused by pollution of wells may be very far-reaching. It is very probable that foul water continuously thrown on the same spot of ground may in time work its way to a well and thus pollute it. Such ground, which is constantly soaked, be it remembered, is never tilled, because tillage is impossible. For ground to be tillable it is essential that reasonable breathing-time should be allowed. I am not altogether sure (although I hardly dare utter such a heresy) that a properly constructed surface well in a selected situation may not prove to be one of the safest sources for water, because it can be inspected with perfect ease, and the fact of accidental leakage into it would become apparent. In this connection it may be well to describe in full detail the well which I have sunk in my garden at Andover, a garden which is rather handsomely manured with human excreta. The well is placed in the very centre of the garden (see fig. 10) at the intersection of two paths—a broad green path and a narrow asphalted path. This situation was chosen for two reasons: (1) that it was as far as possible removed from any accidental pollution from the sewer in the street; and (2) that in the centre of the garden it would theoretically run the greatest chance of fæcal contamination from the manure

used. As the well was sunk solely for experimental purposes this was essential. The garden is on a river-bank and very slightly raised above the level of the water. The well is only some 5 ft. deep, and the water stands at a level (which varies very slightly) of about 3 ft. 6 in. from the bottom. The well is lined throughout from the very bottom to a point some 15 in. above the ground with large concrete sewer-pipes 2 ft. 3 in. in diameter, and these pipes have been carefully cemented at their junctions. Outside the pipes a circle of cement concrete about 4 in. thick has been run in. It will thus be evident, the sides being perfectly protected, that no water can possibly enter this well except through the bottom, all contamination by lateral soakage through the walls being rendered impossible. The well is surrounded by an asphalte path about 3 ft. wide and slightly sloping away from it, and it is encircled by a clipped privet hedge about 5 ft. high, except at those points where the circle of privet is cut by the paths. There is a closely fitting cover of oak, which has an outer casing of lead, and thus all contamination from above is prevented. The water is drawn off through a 2-in. leaden pipe which passes through the outer concrete and the concrete lining pipe, the cut passage for the pipe being carefully closed with cement. The pump is behind the privet hedge, and is provided with a sink and waste pipe which takes the overflow some twenty or thirty yards to a neighbouring stream. In this way the constant dripping of water in the neighbourhood of the well is prevented; for I am very much alive to the dangers attending a constant water-drip, which might be able in time to worm its way through soil and concrete into the well itself. I regard this question of the overflow as one of great importance which is too often neglected. Figs. 10 and 11 show this

well in section and plan. The nearest point to the well upon which any manurial deposit of excreta is likely to be made is on the far side of the privet hedge, and the distance of this point from the bottom of the well is 7 ft.

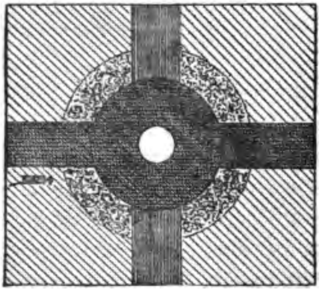

FIG. 10.—PLAN OF WELL, SHOWING ITS RELATION TO PATHS AND HEDGE.

All water which finds its way into the well must have passed through at least 6 ft. or 7 ft. of earth, and, of course, the great bulk of the water has passed through a far greater length. Three chemical analyses of this

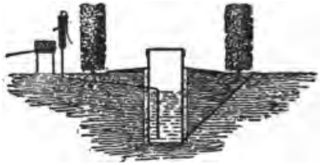

FIG. 11.—SECTION OF WELL, SHOWING CONCRETE LINING AND POSITION OF PUMP.

water, one by Professor Frankland and two by Dr. Kenwood, testify to its organic purity, and three bacteriological investigations have given similar indications of purity. A bacteriological examination of the water from the river Anton and the well water,

made on April 11, 1895, gave 1,133 growths per cubic centimetre for the river and only 7·5 for the well. Of course there may be a dangerous microbe among this small number, but, on the whole, I think the best guarantee of the purity of the water is the condition of the well, which after four years is as clean on the bottom and sides as it was the day it was made. There has been no appreciable increase of sediment on the bottom, and the pebbles are as plainly visible as they ever were. The well is for experimental purposes mainly, but water for garden use is drawn from it, and during the severe frost of 1895–6 my gardener and some of his neighbours were entirely dependent upon it for household purposes. I seldom go into my garden without drinking some of the water, which is clear and delicious, and my visitors seldom escape without drinking some also. I think the well is a very safe one.

N.B.—Since the above was written I have sealed this well, because I found that in spite of all I could do a large number of insects (woodlice, spiders, &c.) got beneath the lid and fouled the water standing in the well.

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